REMARKS

Claims 13-24 and 26 are pending. Claim 13 is amended hereby.

Claims 14, 16, 18, 19, 22-24 and 26 stand withdrawn from further consideration as being directed to a non-elected species.

Claims 13, 15, 17 and 21 were rejected under 35 USC §103(a) as being unpatentable over Shimawaki (U.S.P. 5,903,018) in view of Tanoue et al. (U.S.P. 5,598,015). Favorable reconsideration of this rejection is requested in view of the amendments made herein.

The presently claimed invention has a feature that the base contact layer is formed of a carbon-doped GaAsSb layer or a carbon doped GaInAsSb layer. GaAsSb and GaInAsSb can be doped heavily with carbon in a concentration of about $5x10^{20}cm^{-3}$, so that the base contact layer to be connected to the base layer is formed of the heavily doped p^{++}-GaAsSb layer or p^{++}-GaInAsSb layer, whereby the base region can have a much lower sheet resistance and contact resistance (see, e.g., page 14, lines 10-14 of the specification of the present application). Thus, according to the above-described feature of the present invention, the base contact layer can much reduce a resistance between an intrinsic base region (the region of the base layer immediately below the emitter layer) and the base electrode, even though the base layer does not have a sufficiently low resistance. Accordingly, a much reduced base resistance can be obtained, and a higher maximum oscillation frequency f_{max} can be obtained (see, e.g., page 11, line 21 – page 12, line 4 of the specification of the present application).

The claimed invention also has a feature that the substrate is formed of InP, the base layer is formed of carbon-doped $Ga_xIn_{1-x}As_ySb_{1-y}$, and the emitter layer is formed of InP. That is, the claimed invention relates to InP/GaInAsSb-based heterojunction bipolar transistor (HBT) formed in the InP substrate. In the InP/GaInAsSb-based HBT, the InP substrate must be used as the substrate in order to lattice-match the HBT layers (including the base layer, the emitting layer, and the collector layer) with the substrate. The base contact layer of a carbon-doped GaAsSb layer or a carbon doped GaInAsSb layer can be also epitaxially grown on the base layer of carbon-doped $Ga_xIn_{1-x}As_ySb_{1-y}$ layer. Accordingly, good crystallinity of the HBT layers can be obtained and excellent performance of the HBT can be achieved.

In contract thereto, Shimawaki discloses an AlGaAs/GaAs-based HBT including a base contact layer of GaAs or InGaAs. Thus, the base contact layer of Shimawaki clearly differs from that of the present invention. Shimawaki neither teaches nor suggests the base contact layer of a carbon-doped GaAsSb layer or a carbon doped GaInAsSb layer.

Shimawaki discloses AlGaAs/GaAs-based HBT formed on the GaAs substrate. In the AlGaAs/GaAs-based HBT, the GaAs substrate must be used as the substrate in order to lattice-match the HBT layers with the substrate for the same reason as described above. Thus, one of ordinary skill in the art would not have formed the AlGaAs/GaAs-based HBT layer of Shimawaki on an InP substrate.

As described above, Shimawaki relates to the AlGaAs/GaAs-based HBT formed on the GaAs substrate, so that the HBT of Shimawaki basically differs from the InP/GaInAsSb-based

HBT formed on the InP substrate of the present invention. The selection of the materials of the HBT layers must be epitaxially grown on the substrate. If the substrates differ with each other, selections of materials also differ with each other. The materials applied to the HBT formed n the InP substrate cannot be simply applied to the HBT formed on the GaAs substrate. Thus, one of ordinary skill in the art would not apply the InP emitter layer to the HBT formed on the GaAs substrate.

Tanoue et al. was cited by the Examiner for its disclosure of an InP substrate. Tanoue et al. discloses an InP/InGaAs-based HBT formed in the InP substrate including a base contact layer of WZn. Thus, the base contact layer of Tanoue et al. clearly differs from that of the present invention. Tanoue et al. neither teaches nor suggests the base contact layer of a carbon-doped GaAsSb layer or a carbon doped GaInAsSb layer.

The Examiner states that the InP substrate and the InP emitter layer of Tanoue et al. may be substituted for the GaAs substrate and the AlGaAs emitter layer of Shimawaki, respectively, in order to increase the cutoff frequency of the device by selecting materials that can be used for the same purpose as stated by Tanoue et al. However, as described above, one of ordinary skill in the art would not apply the combination of the materials forming InP/InGaAs-based HBT formed on the InP substrate to the AlGaAs/GaAs-based HBT formed on the GaAs substrate.

As described above, Shimawaki and Tanoue et al. clearly differ from the present invention and do not provide any teaching, suggestion or motivation for rending the present

invention obvious. Thus, the present invention would not have been obvious to one of ordinary skill in the art, even if Shimawaki and Tanoue et al. are combined.

Claim 20 was rejected under 35 USC §103(a) as being unpatentable over Shimawaki and Tanoue et al. in view of Hashimoto et al (U.S.P. 5,846,869). Favorable reconsideration is earnestly solicited.

Hashimoto et al. teaches a thermal treatment for eliminating hydrogen. However, the thermal treatment of Hashimoto et al. is conducted in order to eliminate hydrogen termination and/or OH group terminations adhered to the surface of the base layer. The thermal treatment of Hashimoto et al. is to modify surface state of the base layer. On the other hand, in the present invention, the thermal treatment is conducted in order to eliminate hydrogen in the base layer introduced into the base layer during the deposition of the base layer by MOCVD. The thermal treatment of the present invention is to improve the film quality of the base layer. Thus, the thermal treatment of Hashimoto et al. is clearly different from the present invention.

Hashimoto et al. fails to provide the teachings which Shimawaki and Tanoue et al. lack, as discussed above. Accordingly, the combination of references fails to teach or suggest the claimed invention.

For at least the foregoing reasons, the claimed invention distinguishes over the cited art and defines patentable subject matter. Favorable reconsideration is earnestly solicited.

Should the Examiner deem that any further action by applicants would be desirable to place the application in condition for allowance, the Examiner is encouraged to telephone applicants' undersigned attorney.

If this paper is not timely filed, Applicants respectfully petition for an appropriate extension of time. The fees for such an extension or any other fees that may be due with respect to this paper may be charged to Deposit Account No. 50-2866.

Respectfully submitted,

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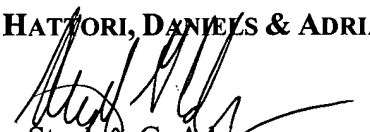

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